

**Evaluation of Alternative Dredged Material Disposal Methods for
Maintenance Dredging at the Mouth of the Columbia River, OR and WA**

Placement of Dredged Material on Benson Beach

Prepared by U.S. Army Engineer District, Portland

24 September 2002

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1. Authority

Energy and Water Development Appropriation Bill (S. 1171) as reported by Conference Committee on Appropriations, 107th Congress, 1st Session. The Committee had provided \$200,000 over the budget request for the Corps to study the impacts of alternate dredged material disposal methods. Specifically, the Corps was urged to examine the impacts of disposing dredged material at Benson Beach.

2. Report Scope

This document is a report that describes the efforts undertaken by the Corps and others, and progress as of 13 September 2002, to investigate the impacts of placing dredged material (sand) on Benson Beach at the Mouth of the Columbia River, OR and WA. Due to the ongoing nature of the monitoring activities at Benson Beach, the report presents a limited scope of conclusions and recommendations addressing potential follow-on dredged material placement activities at Benson Beach. The aim of this report is to convey interim recommendations and “lessons learned” regarding placement of dredged material on Benson Beach.

3. Executive Summary

Subject. The U. S. Army Corps of Engineers is responsible for the operation and maintenance (O&M) of the federal deep-draft navigation channel at the Mouth of the Columbia River (MCR). Each year, approximately 4.2 million cubic yards (cy) of sand is dredged from the 5-mile long MCR channel using 2 hopper dredges; a government dredge and a private industry (contract) dredge. The dredged material is placed in specific open water disposal sites. Present constraints dealing with disposal site capacity for the MCR and potential impacts of using open water disposal sites has led to the perception that placing dredged material on Benson Beach may ameliorate dredged material disposal issues at MCR, and possibly the Lower Columbia River.

As requested by Congress, the U. S. Army Corps of Engineers, Portland District has undertaken efforts to examine the impacts of placing dredged material on Benson Beach. The dredged material under consideration is classified as marine sand and originates from the MCR federal deep-draft navigation channel. Benson Beach lies within Ft. Canby State Park and is located on the southern-most shoreline of the State of Washington, adjacent to the MCR. Ft. Canby State Park is the second most visited state park in Washington. To evaluate the impacts of placing dredged material on Benson

Beach, the Corps conducted an on-site pilot study, during July 2002, whereby a limited quantity of dredged material (sand) was to be placed on Benson Beach using a hopper dredge. Monitoring activities were undertaken to assess operational, environmental, and economic effects of dredged material placement.

Implementation. The Corps had originally estimated that placing even a minimal volume (25,000 cubic yards) of dredged material on Benson Beach would require \$200,000 to \$1 million. Due to the small scale of the Benson Beach pilot study and limited funding, the placement of dredged material on Benson Beach had to be undertaken within the framework of normal MCR maintenance dredging operations. For 2002, the contract for MCR dredging was structured to include an optional bid item for placing dredged material on Benson Beach. Three bids were received. The overall low bid (awarded) had the Benson Beach option for 25,000 cy placement costing \$673,000.

Strong local support for the Benson Beach pilot study resulted in a \$575,000 contribution to the congressional appropriation (of \$200,000); making the pilot study possible. Local support for the Benson Beach pilot study arose from the desirability to maintain or enhance the littoral budget (supply and transport of beach sand) along the southern Washington coast by placing sand dredged from MCR close to or onshore. During 1995-1999, much of the coastal area north of MCR had experienced erosion.

During 16-19 July 2002, 43,727 cubic yards (equivalent to 4,400 dump truck loads or 1% of the annual maintenance dredging at MCR) of sand was placed on Benson Beach, by a contract hopper dredge, at a cost of \$775,000. Local funding originated from Lower Columbia River Ports, Pacific County/Washington State Coastal Communities, and Washington State. More than 98% of the Benson Beach funding went toward getting dredged material “on the beach”. The remainder was used to compile the results of the pilot study.

Development and execution of a monitoring plan was essential to assessing the impacts of placing dredged material on Benson Beach, and was required as a condition of the state permit allowing the placement of dredged material on Benson Beach. The objective of the monitoring program was to determine the fate of dredged material placed on Benson Beach: A) Track the sand that was placed on Benson Beach within context of normal beach change; B) Examine dredging-disposal production at Benson Beach within context to overall MCR dredging operations; and C) Assess the operating environment along the north jetty for future pump-ashore actions. To date, the objectives of the Benson Beach pilot project and the monitoring plan have been realized. Results are summarized below.

4. Lessons Learned

“Technical Soundness” of placing dredged material on Benson Beach. Hopper dredges can be used to place dredged material on Benson Beach, provided that the dredge has “pump-off” capability (the dredge can hydraulically discharge its load of sediment through a pipeline to a offsite location). During the 16-19 July pump ashore operation at Benson Beach, the north jetty provided a lee-shelter for a hopper dredge (from tidal current and west-northwest waves). This means that waves and currents had little or no effect on the overall operation. For pump ashore placement on Benson Beach, dredged

material (sand) can be pumped out from a hopper dredge that is tethered to a flexible/floating pipeline along the south side and in the lee of the MCR north jetty. The sand can be transported over the jetty via pipeline, and hydraulically placed on the inter-tidal area of Benson Beach. Unless the pipeline-to-hopper dredge connection can be used as a secure single point mooring, a tug will be needed to assist the hopper dredge with maintaining position during pump-off or maneuvering for pipe connection near the north jetty (within 500 ft). During the 2002 pilot project, weather at MCR was ideal and the progress during all 19 loads was uninterrupted. It may be unwarranted to base future production rates on the 2002 results.

During July 2002, the distance from hopper dredge during pump-out to the placement site was about 1,000 ft. Depending on the type of hopper dredge, pump out operations could be under taken for transport distances of 3,000-8,000 ft, without the need of a costly booster pump. The learning curve, on the part of the contract hopper dredge and crew, for all aspects of the Benson Beach pilot study was very short; most of the “lessons” were learned during the first pump-out operation.

When dredged material (sand) is placed in the inter-tidal area of Benson Beach during summer, the sand appears to be slowly reworked by waves and currents. The placed sand accumulates within the inter-tidal area near the area of discharge. The sand that was placed on Benson Beach during 16-19 July 2002 has not dispersed as of 18 September. To facilitate northward transport of sand placed on Benson Beach (a desire for some of the MCR stakeholders), the sand should be placed at or below MLLW and be placed further than 1,500 ft north of the north jetty. Dredged material placed closer than 1,500 north of the north jetty will likely migrate southward toward the jetty and be transported offshore by a rip current system.

Based on the behavior of the sand that was placed during summer 2002, the ability to monitor the movement of sand placed on Benson Beach during summer is excellent. The natural processes that occurred at Benson Beach during July-August 2002 produced changes in beach topography and bathymetry that exceeded the accumulation due to the Benson beach placement. The “summer time” capacity of the inter-tidal area at Benson Beach to disperse placed sand may not be sufficient to allow a large scale disposal operation (100,000’s cy) to occur within a small area (5 acres); significant earthmoving effort may be needed to disperse the sand sufficiently. No data is available to assess winter-time dispersion of placed sand on the inter-tidal area of Benson Beach.

“Environmental Acceptability” of placing dredged material on Benson Beach. No environmental studies on species inventories have been conducted at Benson Beach. Nor were any studies conducted to assess the potential biological impacts of dredged material placement at Benson Beach.

Hydraulically placing dredged material on the inter-tidal area of Benson Beach does not adversely affect the amenity of the beach; the dredge material is well suited for direct application on beaches. The MCR sand placed at Benson Beach does not appear to be odorous. The placed sand is very similar to the in-situ, in terms of color and grain size.

If 100,000’s cy are placed during one season, additional reworking by earthmoving equipment may be needed to maintain placed dredged material below the MHHW elevation (this is currently a permit requirement). The active placement

(construction) area must be cordoned off from the public for safety. Obtaining or renewing permits/environmental clearances for quantities larger than 300 Kcy, may be problematic due to the potential disruption of beach use and environmental impacts. Monitoring is need to assess the biologic impact of a larger sand volume placement operation on Benson Beach (100,000's cy), before a very large operation can be conducted (300,000 cy) or if Benson Beach is to be used as a long term disposal site.

"Cost-Effectiveness" of placing dredged material on Benson Beach. Based on the 2002 pilot study, the incremental unit cost for placing 43,727 cy of dredged material (sand) on Benson Beach using a hopper dredge was \$17.45/cy. This is the additional cost for placing the dredged material at Benson Beach, beyond the base cost of placing dredged material at ODMDS E (a nearby shallow water disposal site). The base unit cost for placing dredged material at ODMDS E was \$1.71. Based on summer 2002 conditions, placing dredged material on Benson Beach may replenish the beach, but thus far the sand has been impounded and not made available to the littoral (beach and surf) zone north of the placement area.

Placing dredged material on Benson Beach is an expensive proposition compared to other dredged material disposal methods that also enhance/maintain the littoral budget at MCR. Based on the volume of sand placed on Benson beach during this pilot project (43,727 cy), the unit cost for the Benson Beach disposal method was 11 times more costly than placing sand at ODMDS E and 9 times more costly than placing sand at the Deep Water Site (a disposal site located 8 miles offshore MCR).

As the volume of dredged material placement on Benson Beach increases, the unit cost of mob/demob is reduced (economy of scale). It is estimated that if 500,000 cy were placed at Benson Beach using the same method as in 2002, the (unit) cost per cy placed could be reduced by two-thirds, as compared to the 2002 unit cost. For a placement volume in the range of 500-600 Kcy, hopper dredges (having pump-off capability) offer a viable method for placing dredged material on Benson Beach; provided funding can be secured. For 500,000 cy placement, the incremental unit cost of placing dredged material on Benson Beach is expected to be \$5/cy: To place 500,000 cy it would cost about \$2.5 million. To avoid mobilizing an additional dredge to MCR (incurring an additional \$1.5 million in mob/demob costs), placement of dredged material on Benson Beach using hopper dredges should be restricted to 700,000 cy.

While technically sound, the option of placing dredged material on Benson Beach does not appear to be economically justified using a hopper dredge alone. The incremental costs of placing dredged material on Benson Beach significantly exceed the costs of placing it in open water disposal sites (including the nearshore sites). Other options to decrease the cost of hopper dredge pump ashore placement could be investigated. These options include using a hydraulic pipeline dredge to place sand on Benson Beach via a sediment sump located further upriver. Hopper dredges working at MCR could place dredged material within the sediment sump; feeding the hydraulic dredge.

Hopper dredges cannot be replaced at MCR, they are the only means in which to perform the O&M mission in an open coast inlet on the Pacific Northwest. Using Benson Beach as a primary or even secondary disposal site, in place of open water disposal sites is not possible; for hopper dredges (with pump ashore capability). The ultimate capacity

of Benson Beach to accept dredged material (as a disposal site) is limited to about 12 million cy total. Additional material will either extend to excessive elevations, or it will be easily transported around the north jetty and back into the MCR channel.

5. Recommendations

Based on present economics, the Corps is unable to recommend the use of Benson Beach as an alternative for a primary open water dredged material disposal at MCR; using a hopper dredge pump ashore system. However, ways of decreasing cost should be explored to determine if other methods to place dredged material on Benson Beach could be more economical.

If additional dredged material is to be placed on Benson Beach via the hopper dredge pump ashore method, and if a contract dredge is to be used for the work, then the contract should be developed commensurate with the anticipated funding level for the placement action. This necessitates that the Portland District know of Benson Beach related funding by 10 December in the fiscal year in which MCR dredging is to occur.

Project planners for a Benson Beach placement activity should ensure that all environmental clearances and permits are obtained before contract award (or before a similar operation is begun).

If there is to be additional dredged material placed at Benson Beach, monitoring actions should be adequately funded “up front”, for tracking the movement of placed sand and include the fall, winter, and spring seasons. Biological monitoring of the beach and nearshore (including baseline studies) should be conducted, especially if a large quantity of sand (>100,000 cy) is to be placed on Benson Beach.

The Corps should evaluate other disposal alternatives that benefit the littoral sediment budget, but that do not carry a high mob/demob or recurring cost. Candidates include conventional hopper dredge dumping (or hydraulically discharging directly from the hopper dredge, i.e. spraying) at Site E or other nearshore sites on Peacock Spit. It is recommended that a formal dredged material management plan (DMMP) be initiated for MCR in concert with regional sediment management to evaluate various alternatives in the larger picture of MCR dredging, dredged material disposal needs, and beneficial uses of dredged material.

6. Introduction – Detailed Discussion

Background. The mouth of the Columbia River (MCR) is the ocean gateway for navigation access to/from the Columbia – Snake River navigation system (figure1). The federal deep-draft entrance channel at the MCR extends from RM -3 to RM 3 on the Columbia River (figure2). The MCR channel is 2,640 feet wide and the northerly 2,000 feet is authorized to a depth of -55 feet MLLW with the southern 640 feet authorized to - 48 feet MLLW. Since maintenance dredging at MCR can only be performed by hopper dredges (figure 3) operating during the calm months of summer, the channel is dredged up to 5 feet deeper than the authorized depth to provide project depths for a longer period between dredging operations (fall–spring). Due to the large volume of dredging and short operating season, two hopper dredges are needed to maintain the MCR (1 government owned and 1

private industry dredge). The contract dredge is hired by competitive bid. Refer to Appendix A for a general description of hopper dredge operations.

An average of 4-5 million cy (mcy) of sand is dredged annually at MCR. The hopper dredges place the sand in ocean dredged material disposal sites (ODMDS) and a Section 404 site adjacent to the north jetty. ODMDS E and the north jetty (404) site are used to the maximum extent possible, keeping sediment in the littoral system and helping to protect the north jetty from potential undermining. However, use of ODMDS E and the north jetty site is limited to avoid impacting small boat navigation safety. Dredged material that cannot be accommodated within ODMDS E and the north jetty site is placed at ODMDS F, located 5 miles offshore, beyond the active littoral zone. Beginning in 2003, a Deep Water Site located 8 miles offshore MCR will be used in place of ODMDS F. As the above constraints indicate, selection and use of disposal sites at the MCR is complicated by the need to balance conflicting objectives and uses of the ocean.

Motivation. Since the mid 1990's, state and local interests have requested that the Corps place sand dredged from the MCR Federal navigation channel directly onto Benson Beach (figure 3) to offset beach erosion and supply sand to the littoral system of Long Beach peninsula (figure 4). Benson Beach lies along the 7,500 ft long ocean shore of Fort Canby State Park, and is located in Pacific County, Washington, immediately (north) adjacent to MCR (figures 2-4). Fort Canby State Park is located on a sand spit that had accreted rapidly following completion of the MCR north jetty in 1917. Before construction of the north jetty, the subareal sand spit on which Ft. Canby State Park is founded did not exist. Benson Beach (and most of Ft. Canby State Park) is in part protected and wholly retained by the MCR north jetty. The sand spit on which Benson Beach is founded has been eroding since 1940 with the rate of erosion accelerating in the past decade.

Issues. The Benson Beach "placement" plan was expected to cost significantly more (and introduce more risk & uncertainty) than the USACE base plan for maintenance of the MCR channel. The base plan relies on using available ocean disposal sites for placement of MCR dredged material, principally ODMDS E. USACE has been using hopper dredges to maintain the MCR channel since 1904. About 60% of all material dredged at MCR has been placed within the littoral zone. No MCR dredging-disposal effort has ever placed dredged material directly on the beach. In 2001, the cost of placing dredged material at ODMDS E was \$1.05 per cy; the estimated cost of placing dredged material directly onto Benson Beach was \$2.50-10.00 per cy. The Corps' view is to rely on the use of ODMDS E (or other nearshore sites) to re-introduce dredged material into the littoral system, thus indirectly abating erosion at Benson Beach and points north. Although this method replicates the natural process of transporting (bypassing) sand from MCR to the littoral zone; there are potential impacts to some benthic organisms (crabs) near the disposal sites. These potential impacts are not acceptable for some of the MCR stakeholders.

During 1885-1917, MCR jetty construction facilitated the discharge of 300-500 mcy from the estuary to the ocean/nearshore regions north and south of MCR. Since 1917, this surplus of sand has been dispersed by waves/currents onshore, offshore, and to points north and south. Now, the surplus of sand is beginning to run its course; the surplus is turning to deficit.

Opportunities. Water Resources and Development Act 2000 authorized the Corps to pursue beach protection at Benson Beach under Section 145 or 204 of the continuing authorities program; incremental costs associated with activity beyond the federal “base-plan” would be borne by a local sponsor. During 1999-2001, the Portland District met with state/local officials on several occasions to discuss the Benson Beach placement “proposal”, through a federal/local sponsor cost-shared initiative. No local sponsor was identified.

In July 2001, Congress directed the U.S. Army Corps of Engineers to study the impacts of alternate dredged material disposal methods at the Mouth of the Columbia River (Energy and Water Resources Committee, Senate Bill 1171). Funding for this action was \$200,000. Specifically, the Corps was directed to examine the impacts of disposing of dredged material at Benson Beach and make its recommendations as to whether this alternative is technically sound, environmentally acceptable, and cost effective.

Rather than just perform a “desk study” for the alternative of placing dredged material on Benson Beach, the Corps elected to attempt a pilot project, whereby a limited quantity of dredged material was to be placed on Benson Beach using a hopper dredge during summer 2002. The assessment efforts would: A) Determine the expected cost for such an operation by soliciting competitive bids for the work, and if enough funding was available, award the contract option; and B) Evaluate the safety and feasibility of re-handling sediments dredged from the MCR and placing the sediment in a controlled manner onto Benson Beach. An additional outcome of the pilot study would be to assess the feasibility of beach nourishment as a potential solution to erosion problems at Benson Beach, at the request of the State of Washington and other coastal interests. These issues were examined within the context of the congressional request.

7. Placement of Dredged Material on Benson Beach during 16-19 July 2002

Pre-requisites. Before any dredged material could be placed on Benson Beach, several major issues had to be addressed: A) Obtain environmental permits & clearances, B) Develop contract specifications/drawings, C) Secure adequate funding, and D) Produce a workable monitoring plan.

Obtaining all the necessary environmental permits and clearances required several months to coordinate. The Portland District was responsible for renewing environmental clearances including Clean Water Act state water quality certification (section 401) for MCR maintenance dredging from the states of Oregon and Washington. The US Fish and Wildlife Service and National Marine Fisheries Service were consulted with respect to the Endangered Species Act. Pacific County was responsible for obtaining a permit from Seattle District, pursuant to section 404 of CWA, to allow the placement of dredged fill on Benson Beach. The environmental clearances and permits allowed for up to 300,000 cy of dredged material to be placed within the inter-tidal area of Benson Beach, within 800 ft of the MCR north jetty, over an area of 4.5 acres.

Due to the small scale of the Benson Beach pilot study and limited funding, the placement of dredged material on Benson Beach had to be undertaken within the framework of normal MCR O&M dredging operations. For 2002, the contract (firm

fixed-price competitive bid for the contract dredge) for MCR dredging was structured to contain an optional bid item for placing dredged material on Benson Beach. To be eligible for bidding, the prospective bidder was required to have a hopper dredge that had pump-out capability. The contract option included the hydraulic placement of dredged material (sand dredged from MCR) on Benson Beach: The dredged material would be pumped out of the contract hopper dredge, transported through pipeline (800-1,000 ft), and discharged within the inter-tidal area of Benson Beach (near the north jetty). The timeline for development of the 2002 dredging contract for MCR was very tight and had to be coordinated with several environmental permit/certification activities (table 1).

Upon awarding the dredging 2002 contract for MCR, the overall low bidder had submitted a \$673,000 estimate to place 25,000 cy on Benson Beach. This exceeded the available federal funding by \$473,000. Strong local support for the Benson Beach pilot study resulted in a \$575,000 contribution to the congressional appropriation (of \$200,000); making the pilot study possible. Local funding originated from Lower Columbia River Ports, Pacific County/Washington State Coastal Communities, and Washington State.

Development and execution of a monitoring plan was essential to assessing the impacts of placing dredged material on Benson Beach, and was required as a condition of the state permit allowing the placement of dredged material on Benson Beach. However, none of the Benson Beach funding was dedicated toward monitoring activities. Fortunately, funding and resources for monitoring the Benson Beach pilot project were made available through other sources. The monitoring program consisted of measuring waves and currents in the dredge pump-out area and collecting repeated topographic and bathymetric (underwater topography) surveys of the project area during July – November 2002. The monitoring program was a joint effort between USGS, Washington Department of Ecology, Pacific International (PI) Engineering-LLC, and USACE. The objective of the monitoring program was to determine the fate of dredged material placed on Benson Beach: A) Track the sand that was placed on Benson Beach within context of normal beach change; B) Examine dredging-disposal production at Benson Beach within context to overall MCR dredging operations; and C) Assess the operating environment along the north jetty for future pump-ashore actions. The monitoring program contained no biological impact assessment component.

Table 1. Schedule of tasks required to commence a contract dredging action at MCR.

TASK	MILESTONE DATE
Develop contract scope of work	
Produce schedule and budget for contract	
Set up CEFMS PRC for contract	10 December
Pre-solicitation Coordination	
Produce contract clauses, tech. Specs., and plans	
Print draft contract	8 January
Route draft contract for BCOE review	
Review/comment on contract	
Edit contract per comments	
Final contract prep., printing, & distr.	
Job approval checklist/sign drawings	19 February
Advertise contract	

<u>Bid opening</u>	<u>22 March</u>
Pre-award survey/legal review/documentation	
Secure all necessary environmental permits/clearances	
Award contract	
<u>Notice to proceed</u>	<u>10 May</u>

Placement Operations. During 16-19 July 2002, 43,727 cubic yards of dredged material (sand) was placed on Benson Beach using the direct pump-out capability of the contract hopper dredge *Sugar Island* (NATCO, Inc). The sand was pumped off of the *Sugar Island*, transported through 1,000 ft of pipe, and hydraulically placed within the inter-tidal zone of Benson Beach. There were 19 hopper dredge loads involved in the Benson Beach pump ashore operation. Appendix B lists relevant operation data for each load placed on Benson Beach. Figure 5 shows layout and process of the pump ashore operation for load #2. Total contract cost of the Benson Beach pilot project was \$775,000.

The discharge end of the pipeline was moved onshore and offshore within the inter-tidal area depending upon the tide level; it was advantageous to discharge the sand as close to the water line as possible to promote diffusion/transport of the sand. What was not diffused by the wave action, was done so by a bulldozer distributing the placed sand away from the point of discharge. A permit requirement restricted sand accumulation to a maximum vertical elevation of MHHW. The discharge point was an average 400 ft north of the north jetty. A sand berm was maintained between the discharge point and the north jetty, to prevent excessive overwash from the hydraulic discharge from impinging and undermining the toe of the north jetty. Approximately 80% of the hydraulic discharge was water, 20% was sand. There was very little evidence of an organic or “fishy” smell to the sand as it was being discharged onto the beach. Some of the sand was put into suspension as it reached the waters edge; the suspended sand moved both northward and southward toward the north jetty. Fishermen on the north jetty (fishing on the south side of the jetty) complained that the fishing was “bad” due to highly turbid water full of sand. Either the suspended sand passed through the jetty or the sand went offshore along the north jetty and around the end and then back inside the estuary. The presence of an observable rip current appears to support the latter explanation.

Figure 6 compares dredging-disposal cycle time for loads of dredged material placed at ODMDS E vs. loads placed at Benson Beach. It appears that load #1 represented most of the learning curve for the overall pump ashore operation. The average dredging-disposal cycle time for Benson Beach was 86 minutes (or 93%) longer than placing dredged material at ODMDS E. Figure 7 shows “where” within the tide cycle each pump-out event (load) occurred, and the offshore wave conditions during the 16-19 July pilot project. Pump ashore activities were restricted to daylight hours, but occurred during all phases of the tide. Waves were calmer than normal, out of the west-northwest, and there was no fog. The weather and sea conditions were ideal. It should be noted that although these ideal conditions do occur at MCR during the summer, it can not be assumed that they persist.

Figure 8 compares dredging-disposal production rates for different MCR disposal site scenarios for the contract hopper dredge *Sugar Island*. The daily production rate (cy

dredged-placed/day) for “Benson Beach pump ashore” and the “Deep Water Site” disposal options were estimated to be within 15% of one another. The production rate at ODMDS E was more than 2x that of the Benson Beach pump ashore option. Also shown in figure 8 is the estimated time needed for the *Sugar Island* to complete all MCR dredging assuming specific disposal sites are used. It would take the *Sugar Island* 273 days to dredge MCR if she were the only dredge used, and used only the Benson Beach site.

8. Monitoring the Fate of Dredged Material Placed on Benson Beach

Aerial Photographs. Pre-disposal (9 July) and post-disposal (20 July) conditions of Benson Beach are shown in figure 9. Note the sand accumulation shown in the post-placement photograph.

Topographic Surveys. During July – October 2002, ten topographic surveys are to be taken of the Benson Beach placement area to track the movement of sand placed on the beach, within context of natural changes occurring at the location (WDOE-USGS). The first survey was obtained on 13 July and the last survey will be obtained in the last week of October 2002. Figure 10 compares the pre-disposal topographic survey (13 July) to the first post-disposal topographic survey (20 July). Note that the accumulation of sand due to dredged material placement is discernable in the post-disposal survey. Figure 11 shows the observed topographic change that occurred between 13-20 July. The accumulation of sand due to dredged material placement is obvious. The maximum thickness of the accumulation was about 1.5 meters. The volume associated with observed accumulation was estimated to be 37,000 cy (or 86% of what was placed). Figure 12 shows the observed topographic change that occurred within the area of interest during 20-24 July and 8-21 August 2002. The accumulation has moved southward towards the jetty. The formation of large sand bars offshore the accumulation area is also apparent.

Merged Topographic and Bathymetric Surveys. Three nearshore surveys were conducted during July-August 2002 (USGS). The nearshore surveys were obtained using the USGS’s coastal profiling system, basically a jet-ski with a super-accurate DGPS-based fathometer and heads-up digital navigation package. Figure 13 shows the observed change in the topography and seabed within the project area, during 15 July-8 August 2002. The extent of the nearshore survey is beyond the seaward end of the north jetty. They’re nuts to be out there. Note the elongation of the accumulated sand body and attachment to the north jetty. Large sand bars appear to be moving onshore at some distance north of the north jetty, but as one approaches the north jetty, the sand bars and the accumulation of placed sand appear to be moving offshore along the north jetty. This suggests the presence of a strong rip current near the north jetty.

Figure 14 illustrates the degree of volume changes observed in the accumulated sand body to date. The sand that was placed on Benson Beach during 16-19 July appears to have evolved into a stable configuration, at least for the calm summer conditions prevailing to date at the project site.

Sediment Sampling. Several sand samples were collected through the project area, to document in-situ sand and dredged sand that was placed during the 16-19 July

pilot study. The samples were tested for gradation. Results indicate that the dredged material is very similar to the in-situ sand. More results are pending.

9. MCR Dredging-Disposal Production Rates and Costs

Existing Conditions. With the elimination of ODMDS F after 2002, the Corps will be limited to 3 primary open water disposal sites for the placement of MCR dredged material: ODMDS E (nearshore site), the North Jetty site, and the Deep Water Site. Use of the Deepwater ODMDS will reduce the overall efficiency of MCR dredging-disposal, unless ODMDS E is used more (to offset the use of the Deepwater ODMDS). The North Jetty site will likely be limited to 500,000 cy/yr. However, ODMDS E is believed to have reserve capacity that has not been used for several years. Some of this reserve capacity will need to be used if MCR is to be maintained to its present level using a similar effort as in years past. Figure 15 shows the variation in the annual MCR dredging-disposal progress timeline for various ODMDS E strategies. Moderate use of ODMDS E (2.8 million cy/yr) is required if the deepwater ODMDS is to be used. This finding is especially true if the Benson Beach alternative will be used. Use of ODMDS E is critical to MCR maintenance dredging mission. If ODMDS E is not available to fulfill a capacity of 2.8 mcy, then some other ODMDS within a similar distance to the MCR dredging will need to be obtained.

Benson Beach Pump Ashore Production. Figure 16 shows and optimization of various placement strategies for placing MCR dredged material on Benson Beach, using a contract hopper dredge similar to the 2002 operation. Based on the results, between 500-700 kcy can be placed on Benson Beach using a hopper dredge without having to mobilize a third dredge to MCR. Moderate use of ODMDS E (2.8 mcy/yr) is required.

Costs for Various Disposal Options. Figure 17 compares the unit cost of MCR dredging-disposal in terms of various disposal scenarios. The most likely best case incremental unit cost for placing sand on Benson Beach is about \$5/cy placed; volume limit is 500-700 kcy. The incremental unit cost for the 2002 Benson Beach pump ashore was \$17.45/cy placed. The daily production rate (cy dredged-placed/day) for “Benson Beach pump ashore” and the “Deepwater Site” disposal options were estimated to be within 15% of one another (based on low bid 2002 and figure 8). However, the incremental unit cost (\$/cy dredged-placed) for the Benson Beach option was greater than 10x the unit cost of deepwater option (figure 17), even at relative high volumes or improved scales of efficiency. The reasons for the high unit cost of the Benson Beach pump ashore option are: A) Mob-demob cost for pump-ashore support equipment, B) Recurring cost of support tug, bulldozer, and beach-side support personnel, and C) Double use of dredge-pumps for loading and unloading hopper.

Figure 18 shows the estimated total incremental cost associated with placing MCR dredged material on Benson Beach using a hopper dredge. For 500,000 cy, the estimated incremental cost is \$2.5 million.

10. Acknowledgements

The Benson Beach Pilot Study-Alternative Disposal Site Analysis featured in this report was made possible by the collaborative efforts provided by the ports of the Lower

Columbia River, the State of Washington, and Pacific County/Coastal Communities of Washington. Invaluable technical assistance was provided by the USGS, Washington Department of Ecology, and PI Engineering, LLC in the development and execution of the Benson Beach study. The MCR dredging contractor, NATCO-Inc, deserves praise for accomplishing the Benson Beach placement operation in the unforgiving operating environment at the mouth of the Columbia River, ahead of schedule and without incident.

Appendix A - The Hopper Dredge

A hydraulic hopper dredge is a self-propelled seagoing ship with sections of its hull compartmented into one or more hoppers. It is normally configured with two drag arms, one on each side of the dredge. During dredging, bottom sediment is sucked into the drag arm by hydraulic pumps and deposited into the dredge's hoppers. The dredged material enters the hoppers in slurry form and settles to the bottom as excess water flows over the top of the hoppers. Once the hoppers are full, the drag arms are lifted, and the dredge transits to the disposal area where the dredged material is usually dumped thru doors located on the bottom of the ship (hoppers). In some cases, the hopper dredge can use its pump to discharge the dredged material directly overboard or thru a pipeline to a disposal site not reachable by the hopper dredge (ie. beach, upland, or nearshore locations). The operating parameters for several dredges that have been used at MCR are shown below.

Table A-1. Operating parameters for hopper dredges commonly used at MCR

DREDGE	OVERALL DIMENSIONS			CAPACITY load-average (cy)	VESSEL type	TIME TO PLACE	
	length (ft)	beam (ft)	draft(ft) loaded/empty			open water dump (minutes, per load)	pump-out
<i>Newport(Cntr)</i>	265	55	20/10	3,000	split-hull	4 to 8	N/A
<i>Sugar Island(Cntr)</i>	281	52	19/8	2,300	split-hull	4 to 8	60 to 90
<i>Padre Island(Cntr)</i>	281	52	19/8	2,700	split-hull	4 to 8	N/A
<i>Essayons(Gvt)</i>	350	68	27/15	5,400	bottom doors	6 to 15	120 to 140*
<i>Stuyvesant(Cntr)</i>	372	72	29/17	6,800	bottom doors	6 to 15	130 to 160

* will have pump-out capability in 2003

Hopper dredges are used mainly for dredging in wave exposed or high current areas where traffic and operating conditions preclude the use of more stationary dredges and their attendant pipeline or dump scows. Hopper dredges are effective working offshore and in entrances where sea and weather conditions preclude the use of extensive dredge pipe. Most hopper dredges are capable of operating in ocean swell 10 ft high and they are important for accessing disposal sites at a distance from the dredging location.

Appendix B - Operational and Field Data During Benson Beach Pumpout

Table B-1. Summary of Disposal Operations at Benson Beach, 16-19 July 2002.

Load #	Day after 15 July	Pump Out Time / Duration* Beginning of ops. / minutes	Volume Placed cubic yards	Tide cycle
1	1	7:50 am	83	1450
2	1	12:55 pm	71	2240
3	1	4:00 pm	55	2400
4	1	6:40 pm	67	2330
5	2	7:20 am	77	2220
6	2	10:20 am	74	2420
6	2	1:20 pm	60	2380
8	2	4:00 pm	90	2360
9	2	7:00 pm	102	2420
10	3	7:40 am	88	2340
11	3	10:20 am	56	2350
12	3	1:30 pm	71	2440
13	3	5:10 pm	73	2490
14	3	8:00 pm	73	2420
15	4	7:10 am	68	2360
16	4	9:40 am	81	2260
17	4	12:20 pm	81	2200
18	4	3:00 pm	90	2340
19	4	6:20 pm	74	2310
Avg/day: 5		All Daytime Ops.	Avg: 76	Total: 43,727

* includes pipe hook-up, pumpout, and uncoupling time.